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DESIGN AND ANALYSIS OF SIDE DOOR INTRUSION BEAM FOR AUTOMOTIVE SAFETY

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ABSTRACT *:-* Vehicle side impact is the condition of the 2 vehicles, during which the vehicles touch one another at 90° or at another angle. Space between the traveler and door is extremely less and there's no space for energy absorption throughout the facet collision of the car so, the side impact beam plays a vital role in protecting the occupants. This study is predicated on the choice of the correct cross-sectional facet intrusion beam for an SUV. the side entrance Intrusion Beam is one among the most energy engrossing parts in case of feature sway. This examination paper centers around near investigation of three cross-sectional profiles for side passageway interruption radiates. A nearby FEA and trial study has been performed to examine the static and dynamic conduct of different cross area profiles and materials of the side passage interruption shaft inside the occasion of aspect sway. Similar study of side entrance intrusion beams has been created to search out the force reaction and energy absorption capability of the beam to guard the resident from the facet collision by victimisation FEA software system. Final side entrance intrusion beam are checking on UTM for resistance force is valid on 3 point bending experimental test.

Keywords—Door Intrusion Beam ,side impact, ANSYS, composite, UTM.

I. INTRODUCTION

The Road safety is one amongst the key international considerations relating to the protection of human lives. Every year, 1.2 million individuals die in road connected accidents, and 20-50 million suffer from non-fatal injuries. When a frontal crash, facet impact is the leading reason for road fatalities. coming up with safety systems for preventing the accident, or controlling the damages it inflicts on the passengers once it happens, could be an international analysis subject during which the work developed in the thesis is inserted. The facet intrusion beam could be a protecting part put in within the vehicle door, designed to boost passengers safety within the event of a facet collision. This structure's role is to soak up the utmost quantity of impact energy through the associated elasto-plastic deformation method. Thin-walled beams are frequently applied due to their high energy absorption capability. Metals are unremarkably selected for the beam style, since they blend a high strength in with conjointly high pliability, each significant to energy ingestion. The current work centers around discovering the effect of the cross-sectional unadulterated arithmetic and material of a dainty walled bar in its bowing exhibition. Street mishaps are one among the critical reasons for death in india. In the present vehicle improvement area, auto wellbeing is the major issue. Accidents that are inflicting Injuries that may be controlled considerably if enough attention is given to accident and injury rejection ways. Due to this issue, Vehicle makers are currently victimising varied passive safety devices and have for his or her vehicles, as well as energy gripping steering columns, airbags, exterior door beams etc.

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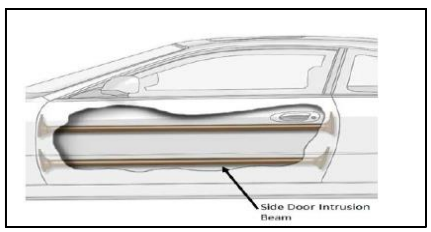

1.1 SIDE IMPACT BEAM

The Side impact door beams are a essential feature of modern cars designed to protect the driver and passengers. The side impact protection beam has to absorb the energy in the door area and shouldn't pass the effect responses to the tenants. Entryway misshapening must be restricted to give a side airbag adequate room between the vehicle's entryway and the seat. The most well-known answers for side effect radiates are expelled aluminum areas , round steel cylinders, and press-solidified or ultra-high strength steel sections. With the increasing size and height of vehicles on the road, including SUVs and vans, side impact beams have become a more popular safety feature for cars of all sizes. The beams provide extra protection during instances when smaller cars may be struck by a larger SUV

II. LITERATURE REVIEW

Kiran C. More , Girish M. Patil, et.al[1], This examination paper centers around relative investigation of three cross-sectional profiles, three checks and three materials for side entryway interruption bar. A nitty gritty mathematical and exploratory investigation has been performed to break down the static and dynamic conduct of various cross segment profiles, checks and materials of side entryway interruption shaft in case of side effect. Near investigation of side entryway interruption radiates has been made to discover the power response and energy

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retention limit of the shaft to shield the tenant from the side crash by utilizing FEA programming.

Yogesh K. Nichit, et.al[2], In this examination paper FEA models have been created with various cross-segment to do three point bowing test. Cycles are taken utilizing LS-DYNA. Further developed boundaries are resolved based on greatest twisting burden limit. The Bending power needed for various areas are assessed and thought about. Ideal plan of 'side interruption shaft' which is best performing for interruption is resolved. Exploration is begun to change the current side effect shaft with the better turn of events and utilizing an alternate cross-areas with same material just as various material then again to diminish the all out weight of the vehicle without limiting the wellbeing of the traveler. T.L. Teng , K.C. Chang, T.H. Nguyen. et.al[3], In this examination paper, full scale side effect test limited component model were introduced. The test mathematical models depend on FMVSS-214. The accident reenactment used the LS-DYNA limited component code. The limit of effect energy ingestion of side entryway is talked about. Examinations on the exhibition of the pillars in side accidents incorporate relocation and interruption estimation of entryway and injury investigation of faker.

John Townsend, Michael Kaczmar, Mohamed El-Sayed et.al[4], This paper presents an exclusive side effect defensive entryway framework inside the space between the external skin of a vehicle entryway and the inhabitant, which will be pretty much as proficient as those generally standard in front facing sway. The principle objective for presenting the side effect primary framework is to expand energy ingestion and limit injury to the occupant.To address a few car wellbeing issues, Joalto Design Inc. has fostered a fundamentally secluded entryway innovation with a few credits. The Joalto XSIB showed a decrease in the Thoracic Trauma Index (TTI). This was diminished by 32% in test 248 and 19.8% in test 249. This expanded the abstract "star" appraisals from a 3 star to a 5 star.

Raghvendra Krishana, Shivangi Yadav, Rajeev Kumar et.al[5],This Research depends on the determination of appropriate cross-part of side interruption shaft for SUV and afterward examination of the aftereffects of post effect test between the real side pillar utilized in vehicle and the bar with chosen cross-area. For determination of side shaft cross-segment three-point twisting test was led on rectangular and roundabout empty cross part of same material and from there on FEA examination was directed and results were thought about for the co-connection of logical information with actual test. Bar with rectangular cross area showed more twisting power taking limit than roundabout.

III. PROBLEM STATEMENT

Side impact of vehicles is the second leading cause of fatalities and serious injuries in the traffic accidents after frontal collisions. The project deals with the evaluation of effectiveness of side door intrusion beam in SUV.

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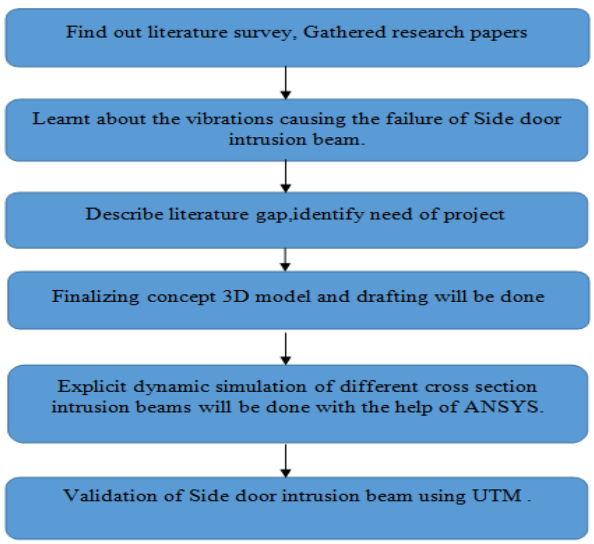
3.1 OBJECTIVES

Modelling offside door intrusion beam of an SUV in CATIA V5R20 software.

This work centers around relative investigation of three cross-sectional profiles and three materials for side entryway interruption shaft. A nitty gritty FEA and trial study has been performed to investigate the static and dynamic conduct of various cross area profiles and materials of side entryway interruption pillar in case of side effect. Final side door intrusion beam will be testing on UTM for resistance force is validated on three point bending experimental test.

IV. METHODOLOGY



4.1 ANALYSIS OF LEAF SPRING SHACKLE

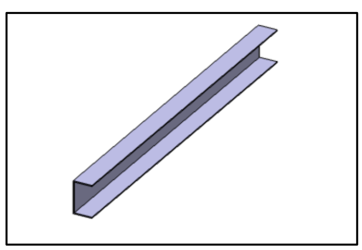


Fig. 01 c-channel

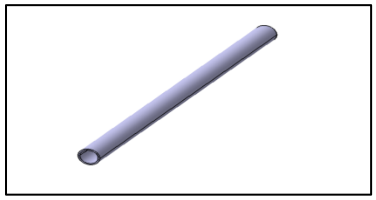


Fig. 02 Round channel

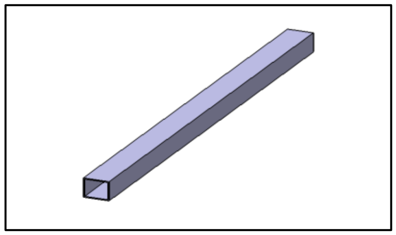


Fig. 03 Square cross-section

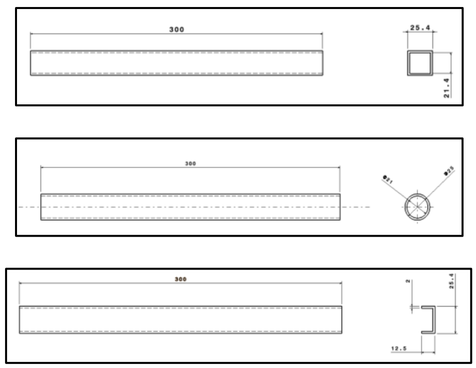


Fig.04 Drafting of different cross-section

4.2 EXPLICIT DYNAMIC ANALYSIS OF SIDE DOOR INTRUSION BEAMS

A. FINITE ELEMENT METHOD

The finite element method (FEM) is the most widely used method for solving problems of engineering and mathematical models. Typical problem areas of interest include the traditional fields of structural analysis, heat transfer, fluid flow, mass transport, and electromagnetic potential. The FEM is a specific mathematical technique for tackling incomplete differential conditions in a few space factors (i.e., some limit esteem issues). To tackle an issue, the FEM partitions a huge framework into more modest, less complex parts that are called limited components. This is accomplished by a specific space discretization in the space measurements, which is carried out by the development of a mesh of the object: the numerical domain for the solution, which has a finite number of points. The finite element method

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formulation of a boundary value problem finally results in a system of algebraic equations. The method approximates the unknown function over the domain. The simple equations that model these finite elements are then assembled into a larger system of equations that models the entire problem. The FEM then uses variation methods from the calculus of variations to approximate a solution by minimizing an associated error function.

B. EXPLICIT DYNAMIC

"Implicit" and "Explicit" refer to two types of time integration methods used to perform dynamic simulations. Explicit time integration is more accurate and efficient for simulations involving – Shock wave propagation – Large deformations and strains – Non-linear material behavior – Complex contact – Fragmentation – Non-linear buckling. Typical applications are drop tests and impact and penetration. ANSYS Explicit Dynamics analysis software provides simulation technology to help simulate structural performance long before manufacture. ANSYS explicit dynamics analysis software solutions are capable of solving short-duration, large-strain, large-deformation, fracture, complete material failure, and structural problems with complex contact interactions.

We are going to perform three different iterations for each cross-section and find out which is better.

C. SQUARE CROSS-SECTION:

GEOMETRY:

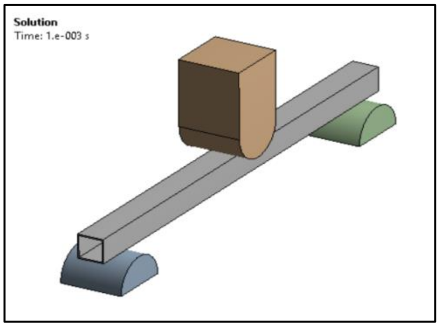

Fig. 05

Innovative Journal for Opportunities and Development in Science & Technology,
Volume 1,Issue 10, June 2021
Paper Id: – IJ2021V1I10 - 14A-D,
ISSN 2582-6026

D. MATERIAL OF SETUP:

Properties of Outline Row 4: Structural Steel

	A	B	C
1	Property	Value	Unit
2	Material Field Variables	Table	
3	Density	7850	kg m^-3
4	Isotropic Secant Coefficient of Thermal Expansion		
6	Isotropic Elasticity		
7	Derive from	Young's Modu...	
8	Young's Modulus	2E+11	Pa
9	Poisson's Ratio	0.3	
10	Bulk Modulus	1.6667E+11	Pa
11	Shear Modulus	7.6923E+10	Pa
12	Alternating Stress Mean Stress	Tabular	
16	Strain-Life Parameters		
24	Tensile Yield Strength	2.5E+08	Pa

Fig. 06

E. MATERIAL FOR COMPONENT:

Properties of Outline Row 3: Low carbon steel

	A	B	C
1	Property	Value	Unit
2	Material Field Variables	Table	
3	Density	7.87	g cm^-3
4	Isotropic Elasticity		
5	Derive from	Young's Modulu...	
6	Young's Modulus	2.05E+05	MPa
7	Poisson's Ratio	0.29	
8	Bulk Modulus	1.627E+11	Pa
9	Shear Modulus	7.9457E+10	Pa
10	Tensile Yield Strength	370	MPa
11	Tensile Ultimate Strength	440	MPa

Fig. 07

F. MESHING:

ANSYS meshing is a general-purpose, intelligent, automated high-performance product. It produces the most appropriate mesh for accurate, efficient Multi-physics solutions. A mesh well suited for a specific analysis can be generated with a single mouse click for all parts in a model. Full controls over the options used to generate the mesh are available for the expert user who wants to fine-tune it. The power of parallel processing is automatically used to reduce the time you have to wait for mesh generation.

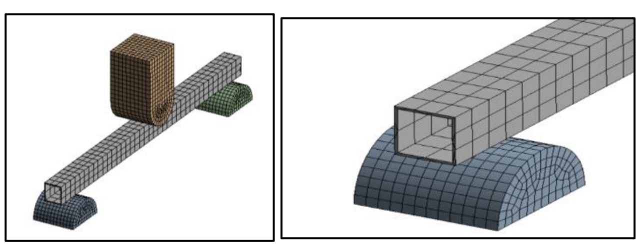

Fig. 08

Innovative Journal for Opportunities and Development in Science & Technology,
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G. NODES AND ELEMENTS:

Statistics	
Nodes	5553
Elements	4266

BOUNDARY CONDITION:

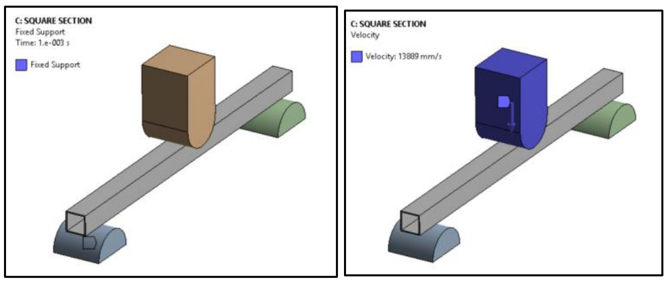

Fig.10

As we have taken the velocity as per the research paper they assumed the speed of impact is 50 Kmph.So we have converted the unit in mm/sec. and the base is considered as a fixed support

FORCE REACTION PLOT:

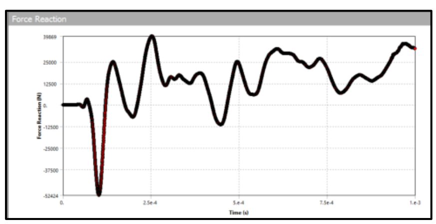

Fig. 11

DEFORMATION AND VON-MISES STRESS PLOT:

Innovative Journal for Opportunities and Development in Science & Technology,
Volume 1,Issue 10, June 2021
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ISSN 2582-6026

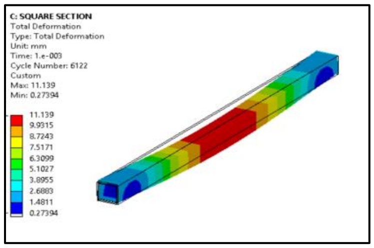

Fig.12 Total deformation plot

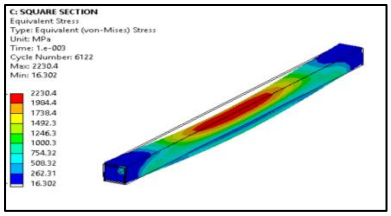

Fig.13 Von-mises stress plot

C-SECTION:

GEOMETRY:

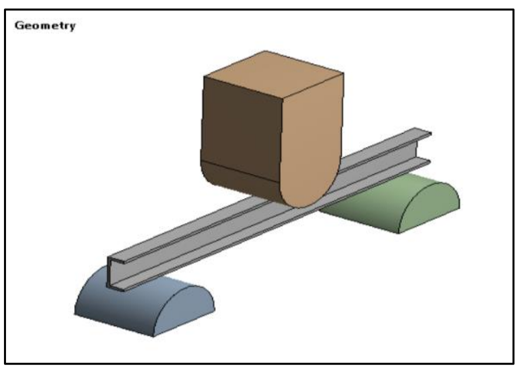

Fig.14

Material for setup:

Properties of Outline Row 4: Structural Steel

	A	B	C
1	Property	Value	Unit
2	Material Field Variables	Table	
3	Density	7850	kg m^-3
4	Isotropic Secant Coefficient of Thermal Expansion		
6	Isotropic Elasticity		
7	Derive from	Young's Modu...	
8	Young's Modulus	2E+11	Pa
9	Poisson's Ratio	0.3	
10	Bulk Modulus	1.6667E+11	Pa
11	Shear Modulus	7.6923E+10	Pa
12	Alternating Stress Mean Stress	Tabular	
16	Strain-Life Parameters		
24	Tensile Yield Strength	2.5E+08	Pa

Innovative Journal for Opportunities and Development in Science & Technology,
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Material for component:

Properties of Outline Row 3: Low carbon steel

	A	B	C
1	Property	Value	Unit
2	Material Field Variables	Table	
3	Density	7.87	g cm^-3
4	Isotropic Elasticity		
5	Derive from	Young's Modulu...	
6	Young's Modulus	2.05E+05	MPa
7	Poisson's Ratio	0.29	
8	Bulk Modulus	1.627E+11	Pa
9	Shear Modulus	7.9457E+10	Pa
10	Tensile Yield Strength	370	MPa
11	Tensile Ultimate Strength	440	MPa

MESHING:

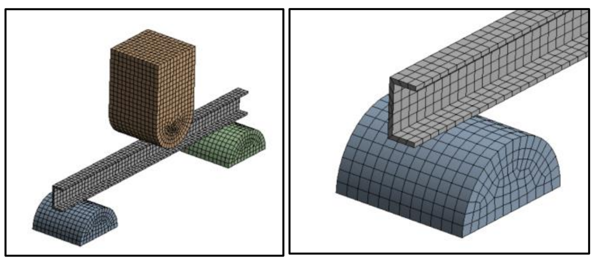

Fig. 17

NODES AND ELEMENTS:

Statistics	
Nodes	8407
Elements	6312

Fig.18

BOUNDARY CONDITION:

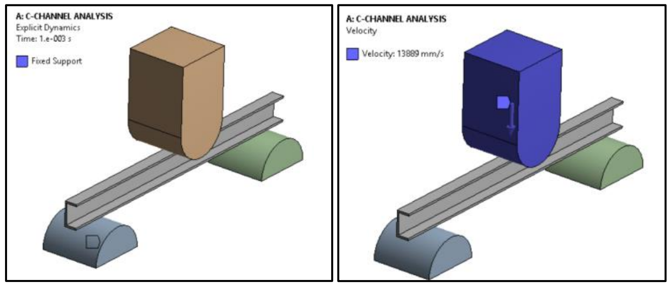

Fig. 19

As we have taken the velocity as per the research paper they assumed the speed of impact is 50 Kmph.

So we have converted the unit in mm/sec. and the base is considered as a fixed support.

REACTION FORCE:

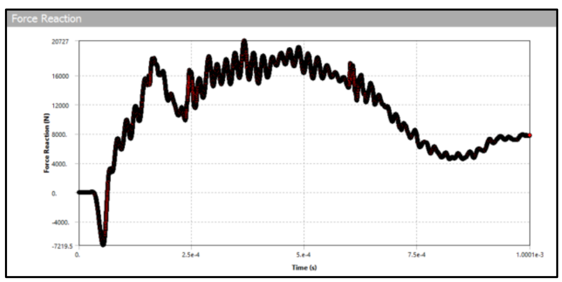

Fig. 20

TOTAL DEFORMATION AND VONMISES PLOT:

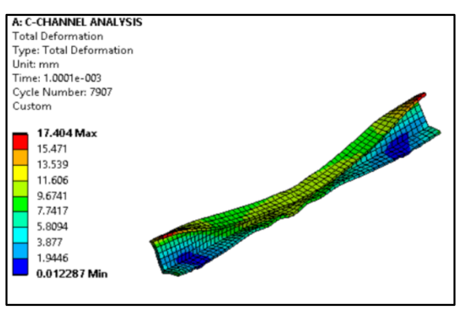

Fig.21 DEFORMATION PLOT

Innovative Journal for Opportunities and Development in Science & Technology,
Volume 1,Issue 10, June 2021
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ISSN 2582-6026

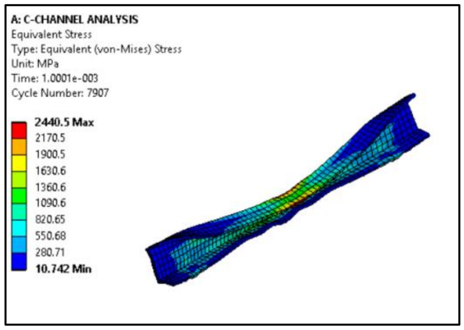

Fig.22 VON-MISES PLOT

CIRCULAR CROSS SECTION:

GEOMETRY:

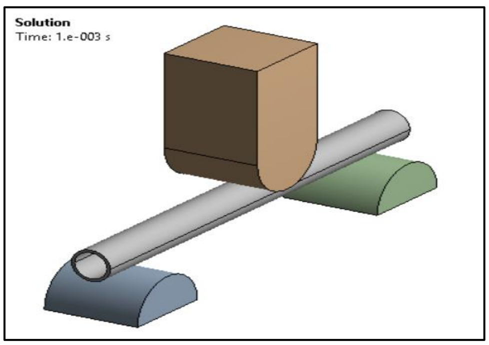

Fig. 23

MATERIAL FOR SETUP:

Properties of Outline Row 4: Structural Steel

	A	B	C
1	Property	Value	Unit
2	Material Field Variables	Table	
3	Density	7850	kg m^-3
4	Isotropic Secant Coefficient of Thermal Expansion		
6	Isotropic Elasticity		
7	Derive from	Young's Modu...	
8	Young's Modulus	2E+11	Pa
9	Poisson's Ratio	0.3	
10	Bulk Modulus	1.6667E+11	Pa
11	Shear Modulus	7.6923E+10	Pa
12	Alternating Stress Mean Stress	Tabular	
16	Strain-Life Parameters		
24	Tensile Yield Strength	2.5E+08	Pa

MATERIAL FOR COMPONENT:

Innovative Journal for Opportunities and Development in Science & Technology,
Volume 1,Issue 10, June 2021
Paper Id: – IJ2021V1I10 - 14A-D,
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Properties of Outline Row 3: Low carbon steel

	A	B	C
1	Property	Value	Unit
2	Material Field Variables	Table	
3	Density	7.87	g cm^-3
4	Isotropic Elasticity		
5	Derive from	Young's Modulu...	
6	Young's Modulus	2.05E+05	MPa
7	Poisson's Ratio	0.29	
8	Bulk Modulus	1.627E+11	Pa
9	Shear Modulus	7.9457E+10	Pa
10	Tensile Yield Strength	370	MPa
11	Tensile Ultimate Strength	440	MPa

MESHING:

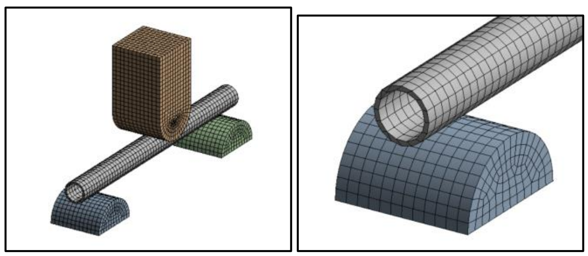


Fig. 25

As we have taken the velocity as per the research paper they assumed the speed of impact is 50 Kmph.

So we have converted the unit in mm/sec. and the base is considered as a fixed support.

BOUNDARY CONDITION:

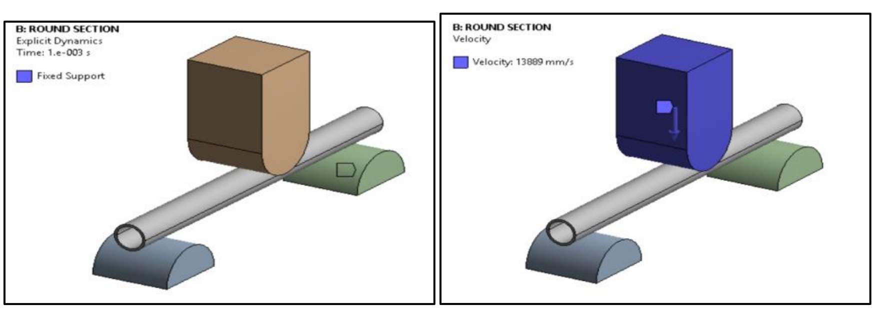


Fig. 26

As we have taken the velocity as per the research paper they assumed the speed of impact is 50 Kmph.

So we have converted the unit in mm/sec. and the base is considered as a fixed support.

REACTION FORCE PLOT:

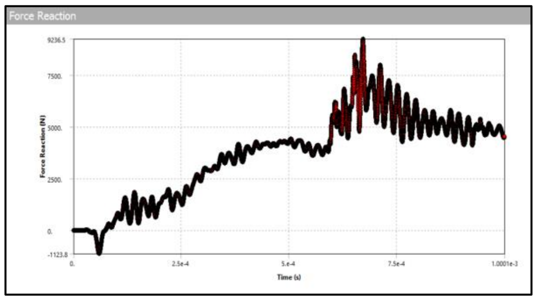


Fig.27

TOTAL DEFORMATION AND VONMISES PLOT:

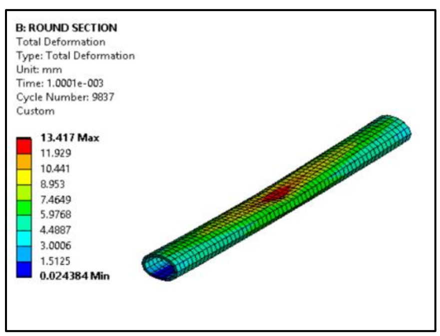
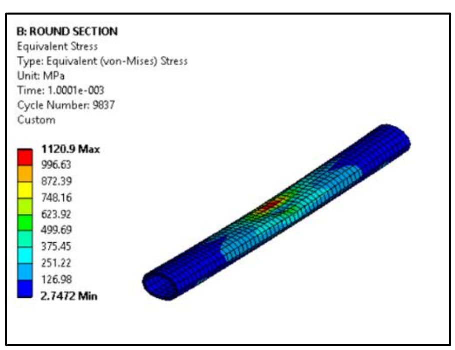


FIG.29 TOTAL DEFORMATION PLOT



Innovative Journal for Opportunities and Development in Science & Technology,
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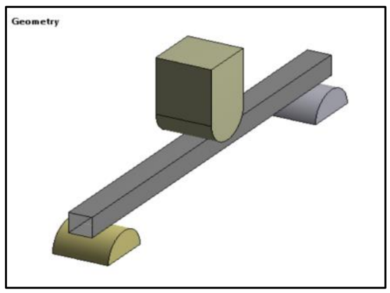
FIG.30 VON-MISES STRESS PLOT

from the above analysis it has been proved that the square cross section has the better reaction force than other to profiles so the square section is the best profile for side door intrusion beam.

to increase the reaction force of the square profile beam reinforcement of composite fiber is done. and the analysis is carried out and further validated through UTM testing.

4.3 ANALYSIS OF REINFORCED SQUARE SECTION PROFILE BEAM:

GEOMETRY:



MATERIAL FOR SETUP:

Properties of Outline Row 4: Structural Steel

	A	B	C
1	Property	Value	Unit
2	Material Field Variables	Table	
3	Density	7850	kg m^-3
4	Isotropic Secant Coefficient of Thermal Expansion		
6	Isotropic Elasticity		
7	Derive from	Young's Modu...	
8	Young's Modulus	2E+11	Pa
9	Poisson's Ratio	0.3	
10	Bulk Modulus	1.6667E+11	Pa
11	Shear Modulus	7.6923E+10	Pa
12	Alternating Stress Mean Stress	Tabular	
16	Strain-Life Parameters		
24	Tensile Yield Strength	2.5E+08	Pa

MATERIAL FOR COMPONENT:

Properties of Outline Row 3: Low carbon steel

	A	B	C
1	Property	Value	Unit
2	Material Field Variables	Table	
3	Density	7.87	g cm^-3
4	Isotropic Elasticity		
5	Derive from	Young's Modulu...	
6	Young's Modulus	2.05E+05	MPa
7	Poisson's Ratio	0.29	
8	Bulk Modulus	1.627E+11	Pa
9	Shear Modulus	7.9457E+10	Pa
10	Tensile Yield Strength	370	MPa
11	Tensile Ultimate Strength	440	MPa

FIG.33

Innovative Journal for Opportunities and Development in Science & Technology,
Volume 1,Issue 10, June 2021
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ISSN 2582-6026

MATERIAL APPLIED ON PIPE:

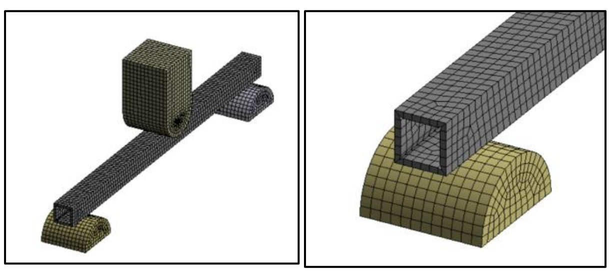
Properties of Outline Row 3: Epoxy E-Glass UD

	A	B	C
1	Property	Value	Unit
2	Density	2E-09	mm^-3 t
3	Orthotropic Elasticity		
4	Young's Modulus X direction	45000	MPa
5	Young's Modulus Y direction	10000	MPa
6	Young's Modulus Z direction	10000	MPa
7	Poisson's Ratio XY	0.3	
8	Poisson's Ratio YZ	0.4	
9	Poisson's Ratio XZ	0.3	
10	Shear Modulus XY	5000	MPa
11	Shear Modulus YZ	3846.2	MPa
12	Shear Modulus XZ	5000	MPa
13	Orthotropic Stress Limits		
14	Tensile X direction	1100	MPa
15	Tensile Y direction	35	MPa
16	Tensile Z direction	35	MPa
17	Compressive X direction	-675	MPa
18	Compressive Y direction	-120	MPa
19	Compressive Z direction	-120	MPa
20	Shear XY	80	MPa
21	Shear YZ	46.154	MPa
22	Shear XZ	80	MPa

MESHING:

ANSYS Meshing is a general-purpose, intelligent, automated high-performance product. It produces the most appropriate mesh for accurate, efficient multiphysics solutions. A mesh well suited for a specific analysis can be generated with a

single mouse click for all parts in a model. Full controls over the options used to generate the mesh are available for the expert user who wants to fine-tune it. The power of parallel processing is automatically used to reduce the time you have to wait for mesh generation.



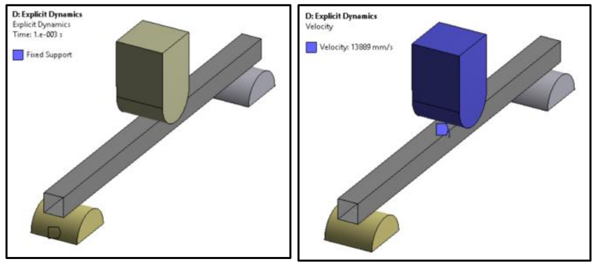
NODES AND ELEMENTS:

Statistics	
Nodes	8667
Elements	7339

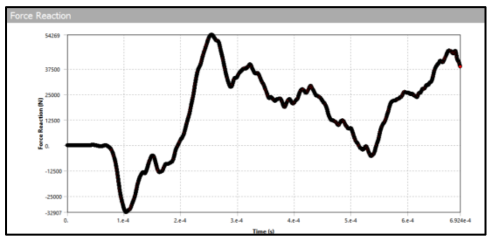
BOUNDARY CONDITION:

A boundary condition for the model is the setting of a known value for a displacement or an associated load. For a particular node you can set either the load or the displacement but not both..

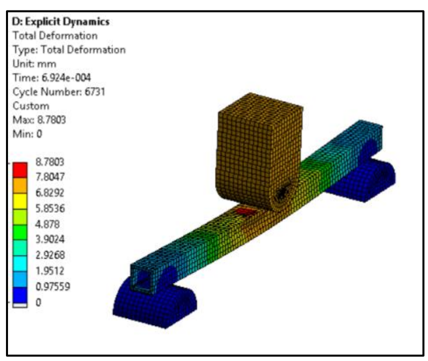
Innovative Journal for Opportunities and Development in Science & Technology,
Volume 1,Issue 10, June 2021
Paper Id: – IJ2021V1I10 - 14A-D,
ISSN 2582-6026



REACTION FORCE GRAPH:



TOTAL DEFORMATION PLOT:



EQUIVALENT STRESS PLOT:

Innovative Journal for Opportunities and Development in Science & Technology,
Volume 1,Issue 10, June 2021
Paper Id: – IJ2021V1I10 - 14A-D,
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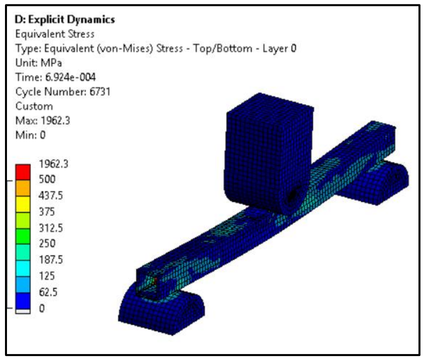

MANUFACTURING PROCESS

Fig. Tools for E-glass fiber reinforcement

V. EXPERIMENTAL VALIDATION:

A Universal Testing Machine (UTM) is used to test both the tensile and compressive strength of materials. Universal Testing Machines are named as such because they can perform many different varieties of tests on an equally diverse range of materials, components, and structures.

All inclusive Testing Machines can oblige numerous sorts of materials, going from hard examples, like metals and cement, to adaptable examples, like elastic and materials. This variety makes the Universal Testing Machine similarly relevant to for all intents and purposes any assembling industry.

The UTM is a versatile and valuable piece of testing equipment that can evaluate materials properties such as tensile strength, elasticity, compression, yield strength, elastic and plastic deformation, bend compression, and strain hardening. Different models of Universal Testing Machines have different load capacities, some as low as 5kN and others as high as 2,000kN.

Innovative Journal for Opportunities and Development in Science & Technology,
Volume 1,Issue 10, June 2021
Paper Id: – IJ2021V1I10 - 14A-D,
ISSN 2582-6026

5.1 SPECIFICATION OF UTM

1	Max Capacity	400KN
2	Measuring range	0-400KN
3	Least Count	0.04KN
4	Clearance for Tensile Test	50-700 mm
5	Clearance for Compression Test	0- 700 mm
6	Clearance Between column	500 mm
7	Ram stroke	200 mm
8	Power supply	3 Phase , 440Volts , 50 cycle. A.C
9	Overall dimension of machine (L*W*H)	2100*800*2060
10	Weight	2300Kg

- Component is placed in the position according to the analytical boundary condition.
- On UTM machine the deflection of beam is given as input as per the deflection the reaction force is plotted on the graph.
- The constraint for deflection of beam is set as 5 mm and the reaction forces are plotted.

Innovative Journal for Opportunities and Development in Science & Technology,
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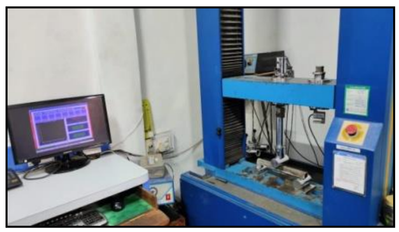

Fig Experimental testing photo

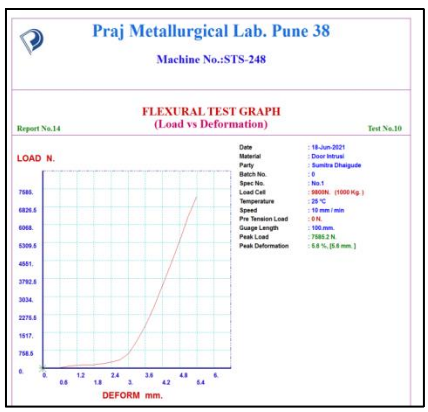

Fig. Experimental result

5.2 EXPERIMENTAL FEA

Innovative Journal for Opportunities and Development in Science & Technology,
Volume 1,Issue 10, June 2021
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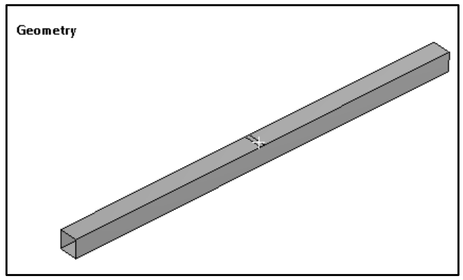
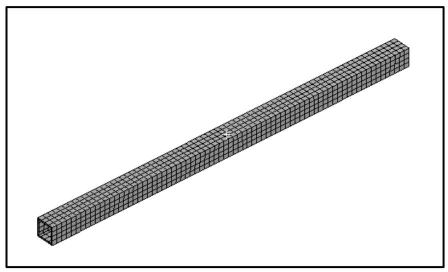


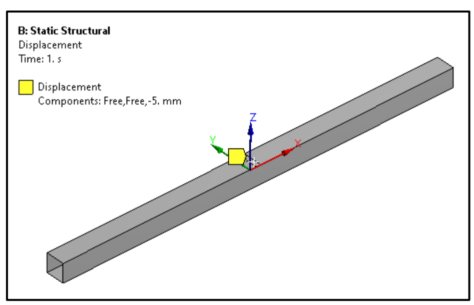
Fig. Geometry

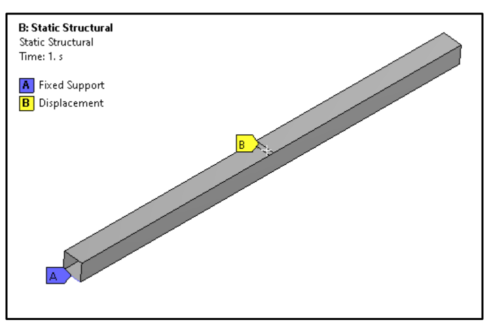


Statistics	
Nodes	1216
Elements	1200

Fig. Meshing

BOUNDARY CONDITION





Innovative Journal for Opportunities and Development in Science & Technology,
Volume 1,Issue 10, June 2021
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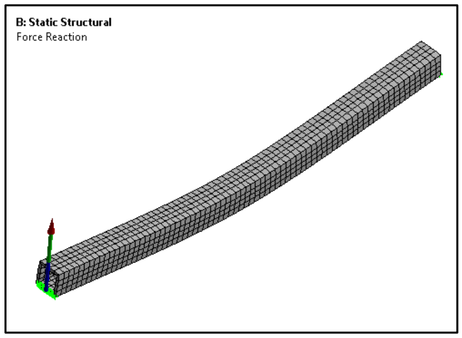
ISSN 2582-6026

Fig. Boundary condition



Maximum Value Over Time	
X Axis	-1.3943e-009 N
Y Axis	-3.5027e-010 N
Z Axis	7909.7 N
Total	7909.7 N

VI. CONCLUSION

Explicit analysis is performed on the different profiles of the intrusion beam, from FEA results the square cross area is seen to have the advantage as contrasted and other two profiles. As the response power of the various profiles are noticed, the response power of the square cross segment is better. As the response power is better, it will respond to the powers applied on the shaft more viably than different profiles. To increase the force reaction of square cross section reinforcement of E-glass fibre is done on the beam by hand lay-up method. This reinforced beam is validated on a UTM machine.

PROFILE	REACTION FORCE	TOTAL DEFORMATION	EQUIVALENT STRESS
C-SECTION	20727	17.404 mm	2440.5 MPa
ROUND SECTION	9236.5	13.417 mm	1962.3 MPa

SQ. SECTION	39869 N	11.139 mm	2230.4 MPa

SR NO	TESTING FOR 5 mm DISPLACEMENT	REACTION FORCE(N)
1	FEA TESTING	7909 N
2	EXPERIMENTAL TESTING	7585 N

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